

STANDARD WEIGHTS AND MEASURES.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

A report of F. R. Hassler, Superintendent of the works of Standard Weights and Measures.

JULY 21, 1840.

Read, and laid upon the table.

TREASURY DEPARTMENT, July 14, 1840.

SIR: I have the honor to transmit, herewith, a report made to this department by Mr. F. R. Hassler, superintendent of the work on standard weights and measures, showing the progress made therein, and representing that the standard yard measures, prepared for the respective States, under the joint resolution of Congress of the 14th of June, 1836, are completed and ready for delivery.

All which is respectfully submitted:

LEVI WOODBURY,
Secretary of the Treasury.

Hon. R. M. T. HUNTER,
Speaker of the House of Representatives.

WASHINGTON CITY, July 10, 1840.

SIR: 1. By the present I have the pleasure to inform you that a number of standard yards (forty) have received their final adjustment and comparison in this establishment, which will be sufficient to enable to offer to each State the one decreed by the joint resolution of Congress of 14th June, 1836, and at the same time to furnish the principal custom-houses with this most desirable part of the standards.

2. A further number of these yards are in such progress as only to need the final verification, which will enable some time next winter to deliver the whole of what is needed, to complete entirely this part of the system of uniform standards.

3. I take the liberty to suggest that this information might be communicated to Congress, in order thereby to invite its members, and particularly the Senators, to call the attention of the Governors of the States to this sub-

ject, that these yards may be called for, under their orders, for their respective States. Those for the custom-houses being, of course, directed to their destination by the Treasury Department direct.

4. This might be at the same time an invitation to those States, who have not yet taken the sets of standard weights, which are here ready for them, (as Pennsylvania, South Carolina, Arkansas, &c.) to induce the Governors to give directions for both *yards* and *weights* to be safely conveyed to their destination.

5. The form selected for these standards, as most proper to secure their safe preservation, has already been mentioned in my report of 1832, upon weight and measure comparisons. In a future general report upon the operations, principles, and works that will have been employed in the whole of the constructions of the uniform standards of weights and measures, a more detailed account will be presented; here is rather to be presented only that part of it which is necessary to guide the persons who may have the guard and use of these standards at their places of deposit.

6. Each standard consists of two parts, being brass bars, of which the one presents the *yard*, and the other the *matrix*, in which the yard fits exactly; they, therefore, preserve one another mutually, and present themselves like one bar. Both bars are of equal thickness, of about $\frac{1}{2}$ inch, the same as the scale of 82 inches of Troughton, which forms the well appropriated original of all the length measures. The one bar presenting the yard length is 1,95 inch broad in its middle part, for exactly the length of the yard. At each end of the yard *exactly*, this breadth is perpendicularly diminished for 0,9 of an inch, so that the outer parts of each end, which extends still 2,5 inches farther, is only 1,05 inch in breadth. The other bar presents in the middle part, for the length of the yard, a breadth of 1,1 inch; at the end of that part its breadth is perpendicularly increased for 0,8 inch, so as to present the form of a lying L, extending 2,4 inches farther outwards, presenting a breadth of 1,9 inch in that extended part.

7. The broader part of the *first* of these bars being adjusted exactly to the length of one yard, within the parts where this breadth is perpendicularly cut off, to the diminished breadth of 1,05 inch, forms most particularly the standard; this part fits so exactly in the narrower middle part of the second bar, which forms a matrix for it, that great care is required, when they are brought together, to move the bars exactly paralleled to each other, that the accurate fitting may not be disturbed by a slant pressing of the part forming the joints, which would make it shake in the fitting.

8. The distance between these two end-joints, presented by its lines of contact, is the actual length of the yard, as standard. The two parts protecting each other by their close fitting, while the outer parts of the same bars have a vacant space between them, in the direction of the length, of about one-tenth of an inch in breadth; which is managed expressly to admit a wedge-formed piece of soft wood, by which the yards are gradually separated, when needed.

9. It is evident, from the above description, that this joint, formed by the perpendicular cuts of these two bars, forms the most important, as well as the most delicate, part of the standard; and must, therefore, not be opened and shut, without there being an important comparison of other measures with the standard to be made by (what is called) contact.

10. When both parts are united, this joint can be brought under two microscopes, and thus may serve for comparing other yards with it, by the

same method which has been employed to compare these very standards with the scale of 82 inches of Troughton, the mean yard of which has been adopted as the most accurate standard of the English measure in this country, and is considered equally so in England. To procure the proper distinct vision for such a use, which is not obtained by a polished surface, the polish of the yard is interrupted at these joints by a narrow strip, from which the polish is taken away for about $\frac{1}{2}$ -tenth of an inch, parallel to the joining of the yard and matrix.

11. To facilitate the tracing from this standard yards for common use, there has been added, upon the matrix part, a yard divided into tenths and hundredths; a right angle and scribe are in the box, so arranged as to facilitate the tracing of the same divisions upon a piece of metal, or wood, laid parallel to it in the place destined for it in the box.

12. Every application of mathematical principles to subjects of practical natural philosophy, furnishes a proof, that the physical means, whatever, and however perfect, they may be, will always leave a certain distance between absolute mathematical accuracy and the result of our best exertions and assiduity. To reduce this distance to its minimum, is the aim of all arrangements, and the hardest task of the operator in such a work. Certain limits are, therefore, always accepted, within which the exactitude must be brought; and the variations within these are to be observed, registered, and, in any case of application, accounted for. The limit within which such a latitude in the accuracy may be allowed, is every time given by the nature of the problem, and the aim and application of the physical result of the operation.

13. In the individual case of the adjustment of length measures, this limit must be brought within a microscopic quantity, so that, in all applications, to even generally considered accurate works, no difference may be observable with the means in application in common life; therefore, also, the yards herewith presented are to be considered in this light. They are all brought within the limit of less than $\frac{1}{75000}$ of an inch; that is, within about $\frac{1}{750000}$ part of the whole, or suppose to 1 yard in about 750,000. While calculating upon the mean of the results of the ultimate comparisons, the accuracy would be within about one yard for one million of yards. Of the variations within this limit, a regular register has been made. To each of the yards will, therefore, be given a certificate or statement of its individual difference from the absolute accuracy. By this means, they will all be exactly comparable at any time hereafter, if they are properly and safely preserved, and compared by means of microscopes, or similar perfectioned means. For that purpose, also, they are numbered, so as to distinguish each individual from the others. In the ultimate account of all the works for the system of standards, the full register of the yards will contain, with each number, the individual standing of each yard in respect to this minute accuracy.

14. For the proper manner of using these standard yards, it will be proper to make again an adequate instruction, to be added to each box, the same as has been done for the weights; which will be joined here.

15. To add a few words upon the other part of the works for the construction of standards, I may state here, that the capacity measures, for liquids, have passed a first adjustment and verification, by the weighing with distilled water, at temperatures near the maximum density of the water; always reducing to that point of temperature, as required by the proper

principles. They are, therefore, in readiness to receive their final adjustment next winter, when the temperature will again be favorable for the work of final adjustment.

16. The mechanical work of the half bushels is very far advanced; a large number of them being constructed, and the boxes for them even made. The weight of the half bushel, in metal and in water, exceeds the capacity of the balances constructed for the standard weights. To obtain the greatest accuracy in weighing, the balance, and the weights for which it shall serve, must be in such proportion to each other that all the necessary strength and stiffness is obtained, with no more weight of the balance (which always acts as a dead weight) than what is required to obtain these qualities; for it is evident that, by otherwise equal accuracy of workmanship, the sensibility of the balance is determined by the absolute weight of the balance and the weights together. This dictates, for this case, a balance of considerable strength, because it must be able to bear the double weight of the bushel with its appurtenances. Such an appropriate balance is now constructing here, of a solid brass beam, and with such arrangements as will serve conveniently in its special use.

17. After this balance will be finished, it will be proper to begin the works for the balances to be made for the States, in conformity to the joint resolution of Congress of July, 1838.

I have the honor to be, with perfect respect and esteem, sir, your obedient servant,

F. R. HASSLER.

Hon. LEVI WOODBURY,

Secretary of the Treasury of the United States.

Instruction upon the safekeeping of the standards of yards, and their use in comparisons, &c.

1. The standard shall never be touched with the naked hand, warm, or in any way damp, from perspiration or otherwise; it is proper not to suffer any dust to collect upon it, which could occasion hard rubbing; any dust is to be removed, in any case, by wings or feathers of a *wild bird*, because they will not occasion any scratches, like the wings of fowls, ducks, &c., would do.

2. It must not be removed from its place in the box, except for the most important comparisons of metallic measures.

3. To take it out of the box, if necessary, the following is the best process:

While the box is shut and hooked, turn it upside down upon some table; by that means the standard will come to lie upon the velvet lining of the cover; in this position the box is opened, and the two parts of the standard may be separated by gently taking hold of the two ends, and, by equal and gradual motion, applying the thumb to the yard part, and the middle finger to the matrix part, pressing them apart from one another; or, also, by inserting into the space left between the two bars at those places, two light pieces of soft wood at each side, uniformly, until entirely disengaged. Then the parts may be removed for use, each separately, with proper care and management; both parts cannot be moved together, because their pressure

and friction within one another can and shall not be such as to hold them together sufficiently for that purpose.

4. In putting the two parts together, the same movements of the two parts parallel to one another, are to be made gradually and gently, in inverted order and effect; after an entry of the yard into the matrix is first obtained, by a contact of less than five hundredths of an inch at each end, until the two parts close fully together.

5. For any common comparison of scales of wood, or other materials, or the division of any such scale, the part thus fixing the actual standard is not to be used; therefore there is added upon the matrix a scale divided into hundredth parts of the yard; this division being habitually, and most conveniently, used in the custom-houses.

6. To use this division, to trace a measure from it upon a rule, yard, stick, or other similar, there is added in the box a right-angle, with a handle over it, which is placed by its under-projecting part in contact with the outer edge of the matrix, while the upper part, projecting in both directions perpendicularly over it, is applied to any of the divisions by the edge of the farther part, while its nearer part, in continuance of the same line, serves to trace the corresponding division upon the bar to be divided; for that operation, the bar to be divided is placed in the near part of the box excavated for that purpose. In this place, or deepening, the scale to be divided is held fast by pressing it to the inner side of it, by means of the small wedges and the brass pins projecting from the nearest edge, and pressing the bar inward from the side nearest of the box; this inner partition of the box is parallel to the standard, when this touches the near side of its location, forming the partition between the two. In this position the division is to be made.

7. The arrangement just described will be found sufficiently accurate for common measures; but no beam-compasses of any kind are admissible, in no way whatever. For fully accurate copies of the standard, from between the butting-pieces, various methods may be used, completely different, and grounded upon various principles; as, principally, by means of microscopes and tracer, or by the feeling lever. The description of these, in detail, would be too long here; they belong more particularly to the actual scientific use of standards, and may therefore best be supplied by the man of science having charge of the work. My report of 1832, upon the comparison of standard weights and measures, may be a guide in the case; and various other works, well known to professional men, will assist in planning arrangements, according to the means and circumstances of a given case.

8. When brass scales are to be compared with the standard, or to be made from it, the equality of the metal with that of the standard requires only the precaution to have both standard and scale of the same temperature; which is generally obtainable by laying them together the evening before the work, and by the proper care not to give them unequal warmth, by touching, by draughts of air, or such like. But, when different metals are used, it becomes necessary to keep account of the difference of expansion of the metals employed.

9. To facilitate the reductions of yards, of different or the same metal, for different temperatures, it may be convenient to find here the expansion for the following metals, viz:

A yard expands, for one degree of Fahrenheit's in temperature, in decimals of an inch—

In platinum	=	0,0001848384
In brass	=	0,0003732508
In iron	=	0,00025068726

Which may serve for the reduction to a given temperature, of yards, for these three metals, which are those most habitually used.

WASHINGTON CITY, July 10, 1840.

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